The appearance of the mandibular condyle varies greatly among different age groups and individuals. Osteology states that morphologic alterations occur on the basis of simple developmental variability as well as remodeling of condyle to accommodate developmental variations, endocrine disturbances, radiation therapy, malocclusion, trauma and other developmental abnormalities and diseases. The mandibular condyle varies considerably both in size and shape. When viewed from above, i.e., the bird’s eye view condyle appears roughly ovoid in outline. It is 15-20 mm mediolaterally and 8-10 mm postero-anteriorly. There is great variation in the size and shape of the components of the temporo-mandibular joint (TMJ), and its relationship to each other.

It is often assumed that the normal condylar head must have a convex configuration throughout and that symmetry should exist between contralateral sides in the same individual. Several studies have attempted to evaluate the morphology of the human condyle. Variation in the human mandibular condyle shapes was noted by previous researchers. A normal variation of the condylar morphology occurs with age, gender, facial type, occlusal force, functional load, malocclusion type and between right and left sides.
Maxillofacial radiography by means of orthopantamogram (OPG) is used as a routine screening tool in diagnosis and treatment planning in various fields of dentistry, and is found to be less expensive when compared to other advanced imaging modalities like CT, MRI and CBCT.\textsuperscript{[5]} In a panoramic image, different shapes of the coronoid process, condyle and sigmoid notch can be often appreciated.\textsuperscript{[6]} It also yields a favorable cost-benefit relationship and exposes patients to relatively low doses of radiation.\textsuperscript{[7,8]} However, due to lack of epidemiological data, there is not enough information to determine the true frequency and characteristics of this morphological variation of condyle. The human condyle has a capacity for remodeling which are influenced by a variety of factors which can result in morphological diversity and variations in shape. Several studies have dealt with the position of the condyle but not much emphasis has been laid on the shape of the condyle.\textsuperscript{[9,10]} The present study is aimed at observing and recording the variation in the shapes of condyle on an OPG and thereby evaluate whether the determination of the shapes could aid in diagnostics.

**METHODOLOGY**

The present study was conducted in the Department of Oral Medicine and Radiology. A total of 1460 digital OPGs obtained from November 2017 to May 2019, of patients over 20 years of age, which were available as soft copies in the archival records of our Radiology Department were selected for the study.

The Institutional Ethical Committee approval was obtained before commencement of the study. Digital Ortho-pantamographs (OPG) were obtained from Carestream Digital Health INC- France, Model- CS-8100SC using charged coupled device sensors under standard exposure factors (KVp of 90, duration of 13s, and current of 9 mA). Digital OPG’s free of any projection errors, which showed Condylar head clearly and accurately with optimal density and contrast were selected for the study. Radiographs with positioning and magnification errors were excluded during the evaluation process. All OPGs were made and evaluated in the same manner by two oral radiologists for the formulation of operational definitions. Condylar morphology of four types were recorded according to the classification done by Chaudhry et al.\textsuperscript{[11]} namely: Type I - Oval shape, Type II - Diamond shape, Type III - Bird beak shape, Type IV - Crooked finger shape. Apart from this, some OPGs showed combination of above mentioned shapes which was added in above classification.

Data regarding age, sex, right and left sides, length, and type were transferred to a spreadsheet in Microsoft Excel 2007. Frequency and distribution tables of BMCs were

RESULTS

The following shapes were perceived among the western Maharashtra population namely, (i) Oval, (ii) bird beak, (iii) diamond, and (iv) crooked finger in 1460 OPGs. The most common shape was found to be oval 786 (53.83%), followed by bird beak 195 (13.35%), diamond 98 (6.71%), and crooked finger 43 (2.98%). The combination of the above shapes was seen in 338 (23.15%) radiographs [Table 1].

Out of 1460 radiographs 857 (58.69%) belongs to males and 603 (41.30) belongs to females with male predominance. The most common shape observed among both the males and females was the oval where the former was accounted for 447 (52%) while the latter 339 (56.21%) followed by bird beak, diamond and crooked finger in both males and females. In males bird beak was seen in 116 (13.53) followed by diamond 57 (6.65%) and crooked finger 26 (3.03%). In females bird beak was seen in 79 (13.10%) followed by diamond 41 (6.79) and crooked finger 17 (2.81%). Out of 857 male patients radiographs combinations of the shapes was seen in 211 (24.62%) and out of 603 females patients radiographs 127 (21.06%) combinations shapes were seen [Table 2].

Of the 1460 OPGs 338 (23.15%) showed various combinations of condyles. The shapes predominant in both genders were determined. Of 338 OPGs which showed combinations of shapes 211 (62.42%) belongs to males patients and 127 (37.57%) belongs to female patients.

Oval/oval combination was most prevalent in both male 86 940.75%) and female 63 (49.49%) OPGs, followed by oval/bird beak, oval/diamond, bird beak/bird beak and crooked finger/crooked finger [Table 3].

Table 1: Different shapes of Mandibular condyles.

<table>
<thead>
<tr>
<th>Shapes of condyles</th>
<th>Numbers (%)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oval</td>
<td>786</td>
<td>53.83</td>
</tr>
<tr>
<td>Bird beak</td>
<td>195</td>
<td>13.35</td>
</tr>
<tr>
<td>Diamond</td>
<td>98</td>
<td>6.71</td>
</tr>
<tr>
<td>Crooked finger</td>
<td>43</td>
<td>2.98</td>
</tr>
<tr>
<td>Combination of above</td>
<td>338</td>
<td>23.15</td>
</tr>
<tr>
<td>Total (%)</td>
<td>1460</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 2: The shapes commonly occurring in both genders.

<table>
<thead>
<tr>
<th>Shapes commonly seen</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oval</td>
<td>447 (52.15)</td>
<td>339 (56.21)</td>
<td>786</td>
</tr>
<tr>
<td>Bird beak</td>
<td>116 (13.53)</td>
<td>79 (13.10)</td>
<td>195</td>
</tr>
<tr>
<td>Diamond</td>
<td>57 (6.65)</td>
<td>41 (6.79)</td>
<td>98</td>
</tr>
<tr>
<td>Crooked finger</td>
<td>26 (3.03)</td>
<td>17 (2.81)</td>
<td>43</td>
</tr>
<tr>
<td>Combination of above</td>
<td>211 (24.62)</td>
<td>127 (21.06)</td>
<td>338</td>
</tr>
<tr>
<td>Total (%)</td>
<td>857 (100)</td>
<td>603 (100)</td>
<td>1460</td>
</tr>
</tbody>
</table>

Table 3: Occurrence of combination of shapes of Mandibular condyles.

<table>
<thead>
<tr>
<th>Combination of condylar shapes</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oval/Oval</td>
<td>86 (40.75%)</td>
<td>63 (49.60%)</td>
</tr>
<tr>
<td>Oval/Bird beak</td>
<td>45 (21.32%)</td>
<td>31 (24.40%)</td>
</tr>
<tr>
<td>Oval/Diamond</td>
<td>38 (18)</td>
<td>20 (15.74%)</td>
</tr>
<tr>
<td>Bird beak/Bird beak</td>
<td>24 (11.37%)</td>
<td>8 (6.29%)</td>
</tr>
<tr>
<td>Crooked finger/Crooked finger</td>
<td>18 (8.53%)</td>
<td>5 (3.93%)</td>
</tr>
<tr>
<td>Total</td>
<td>211 (100)</td>
<td>127 (100)</td>
</tr>
</tbody>
</table>

DISCUSSION

The appearance of the mandibular condyle varies greatly among different age groups and individuals. Morphologic changes may occur on the basis of simple developmental variability as well as remodeling of condyle to accommodate developmental variations, malocclusion, trauma and other developmental abnormalities and diseases.\(^\text{[12]}\)

Condylar shape classification has been elaborated and argued for decades by means of antero-posterior, superior and lateral view radiograph.\(^\text{[13]}\) Several authors have discussed about various types of condyle without giving proper classification.\(^\text{[14]}\)

In 1960s and 1970s studies were performed mainly on dry skulls and autopsy materials.\(^\text{[15-17]}\) These studies used macroscopic observations, radiological cephalometry and tomography. In 1961, Yale et al.\(^\text{[15]}\) was the first one to report about the different shapes of mandibular condyle. Initially Yale classified condylar head based on superior view into three categories namely concave, convex and flat, however later on he simplified it into four categories namely convex, flattened, angled and rounded.\(^\text{[15,16,18]}\)

A study in 1980’s on mandibular condyle morphology in relation to malocclusion in children revealed that the condylar size in males was greater than in females and midline discrepancy significantly altered the increase in condylar size during growth.\(^\text{[19]}\)
Evaluation of shape of the condyles upon surgical exposure of TMJ revealed that most condyles had a normal size and shape. Other varieties like excavated form, oblique shape, small round condyles and flattened condyles were also noted.\(^\text{[20]}\)

Radiographic analysis showed that in the anterior view, 58.4% of the specimens exhibited a plane or slightly convex shape, 25% a well-rounded or convex shape, 16.6% were shaped like an inverted "V", and only 3.1% were convex. In the upper view, many of the condyles (60%) had an oblong shape, 20% were pear-shaped and laterally tapered, 18.4% were pear-shaped but medially tapered, and only 1.6% had a rounded or oval shape. Of the skulls examined in the lateral view, 55% were pointy or shaped like an inverted "V", 31.7% had a convex shape, and 13.3% were plane or slightly convex.\(^\text{[21]}\)

By using high resolution CT images condyle morphology was classified as flat, round, convex, concave and angled. Convex type was observed very frequently followed by angled, concave and round. In women convex type was observed predominantly, whereas in men concave type.\(^\text{[22]}\)

Using different radiographic techniques many studies were done to detect the condylar morphology, to compare the accuracy of detecting condylar changes in TMJ disorders. Previous studies regarding the morphology of condyle have shown that shape variability of the condyle was mainly related to inclination of the condylar head, shape variability of the fossa was related to inclination of the eminence and fossa height.\(^\text{[23]}\)

A study conducted by Oliveira et al.\(^\text{[24]}\) to assess the condyle morphology on OPG of asymptomatic TMJ patient, had shown the round shape to be more frequent followed by pointed and flat shapes, which was similar finding among females in the present study.

The studies reported by Ribeiro et al.\(^\text{[25]}\) and Choudhary et al.\(^\text{[11]}\) pertaining to the Brazilian and East Indian population respectively had shown that round/oval shape to be common in both the sexes which goes in accordance with our study but with correspondence to the females of our ethnic group.

Singh and Chakrabarty\(^\text{[13]}\) conducted study to determine and classify the shape of condyle on OPG. The sample included 100-OPG from 14 to 45 years old, 52 males and 48 females. Shapes were classified as rounded, angled, flattened and mixed types in the lateral views.
Round type of condyle is more frequent than other varieties and not associated with any sex predilection.

Sahithi et al.\textsuperscript{[5]} conducted study on 200 digital OPGs comprising of both the sexes and the different shapes of the coronoid process, condyle and the sigmoid notch were traced on projection sheets for both the right and left sides. Study has illustrated various morphological shapes of condyle. The most commonly observed cobdylar shape among the males and females were angled and round shapes respectively. These variations when compared on both the sides had shown no statistical significance.

Sonal et al.\textsuperscript{[3]} conducted study in 200 digital OPGs taken for routine investigation to evaluate condylar morphology. Of the 200 pairs of condylar heads evaluated, 60% were oval in shape, followed by bird beak (29%), diamond (9%) and least being crooked finger (2%). Oval-oval was commonly occurring combination (67%), whereas crooked/ crooked finger was a rarity.

Our study had showed the most common shape observed among both the males and females was the oval and least was crooked finger. Oval/oval combination was most prevalent in both male and female and least was crooked finger/crooked finger. The results of the present study were similar to those of Sonal et al.\textsuperscript{[3]} and Chaudhary et al.\textsuperscript{[11]}

**CONCLUSION**

The present study is an attempt to scout the prevalent radiographic shapes of the condylar head on the OPG. Low exposure dose and ease of prescription makes OPG a common choice of imaging prescription. Evaluation of condyle on OPG seems to attract clinicians to make fine observations. Oval-oval being most common in both genders. More sample size and evaluation of other parameters may aid in giving more information. Within its limitations, confining to our population, the present study had witnessed various morphological shapes of condyle using the panoramic radiographs as a probable approach for personal identification.

**REFERENCES**


